

The background of the slide is a photograph of a calm lake. In the distance, there are rolling hills and mountains under a clear blue sky. On the right side, a small cluster of houses is visible on a hillside overlooking the water.

Our Work is Directed at:

1. Understanding What Controls Water Quality and Ecological Health in Clear Lake

2. Creating Predictive Tools that Enable Stakeholders to Evaluate Future Options



UCDAVIS

Tahoe Environmental
Research Center

Dr. Alicia Cortés
Blue Ribbon Committee Meeting #9,
March 11th, 2020

2019 TERC Progress in Clear Lake

- The field and laboratory measurements we have been taking are providing the ***quantitative understanding***. They build on past investments in Clear Lake Science
- The measurements are essential to **build, calibrate and validate the predictive models**

Let's Do a **Modeling Experiment**:

Release 3 particles into the the **Upper Arm** in spring (April 11, 2019) and let them move under the influence of the measured conditions for 2 weeks.

Will they ...

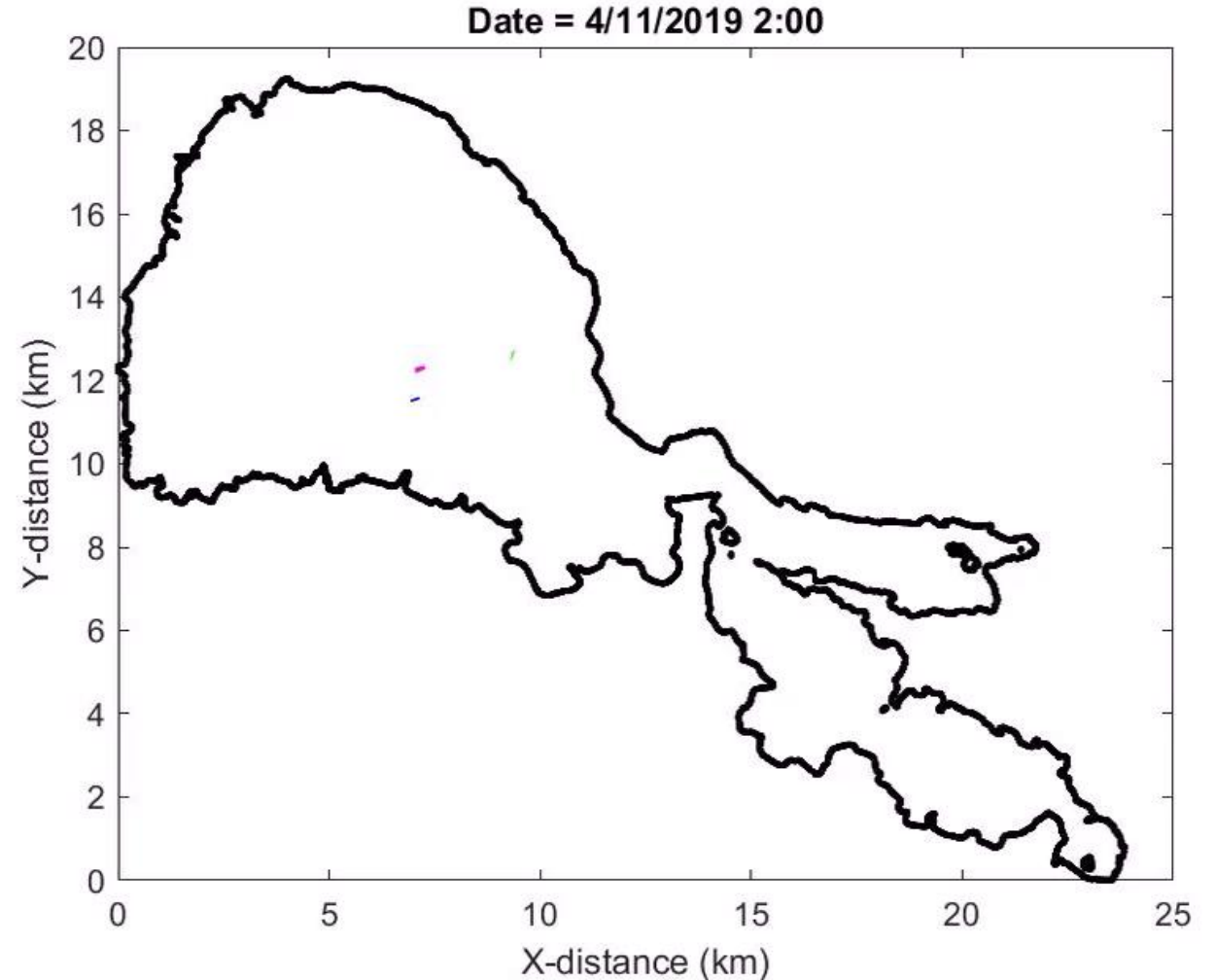
1. **Stay** in the Upper Arm?
2. **Move** to the Oaks Arm?
3. Move to the Lower Arm?



The particles could be algae, phosphorus-rich sediment, particulate mercury....

Or we could have done a similar experiment with **dissolved material**

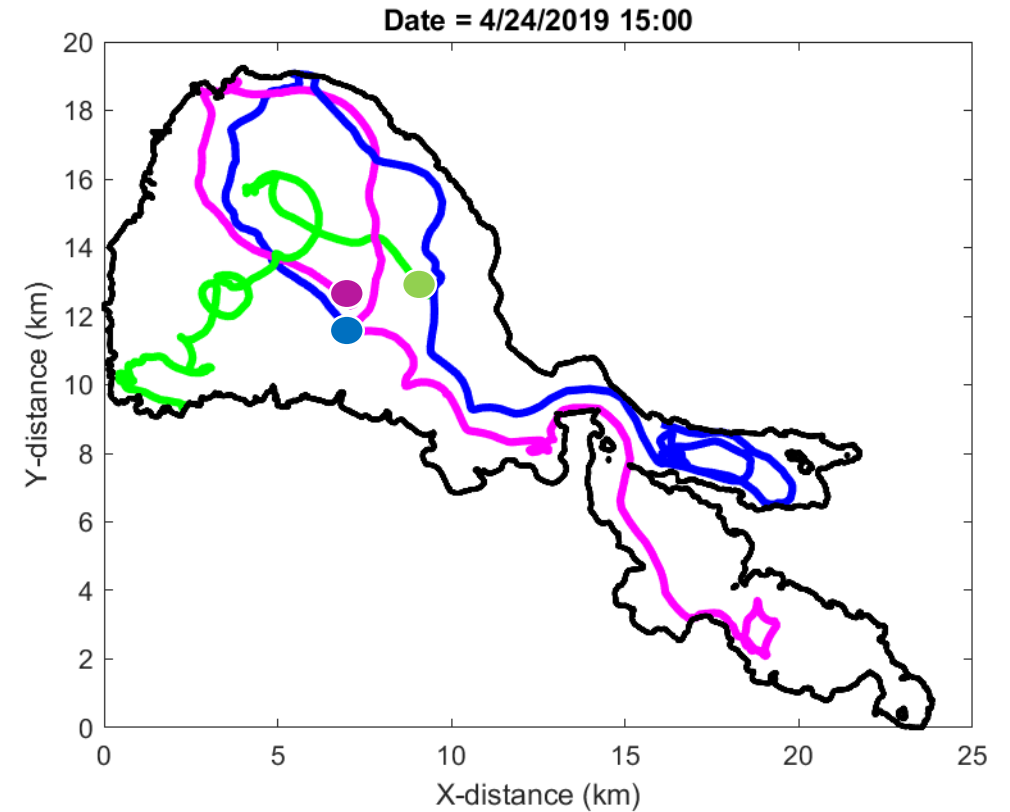
3-D model result showing the pathways of 3 particles released in the Upper Arm



They followed completely different paths!

How Particles and Solutes Distribute in Clear Lake Impacts Water Quality

- Nutrients
- Contaminants (e.g. Mercury)
- **Dissolved oxygen**
- Algae ...



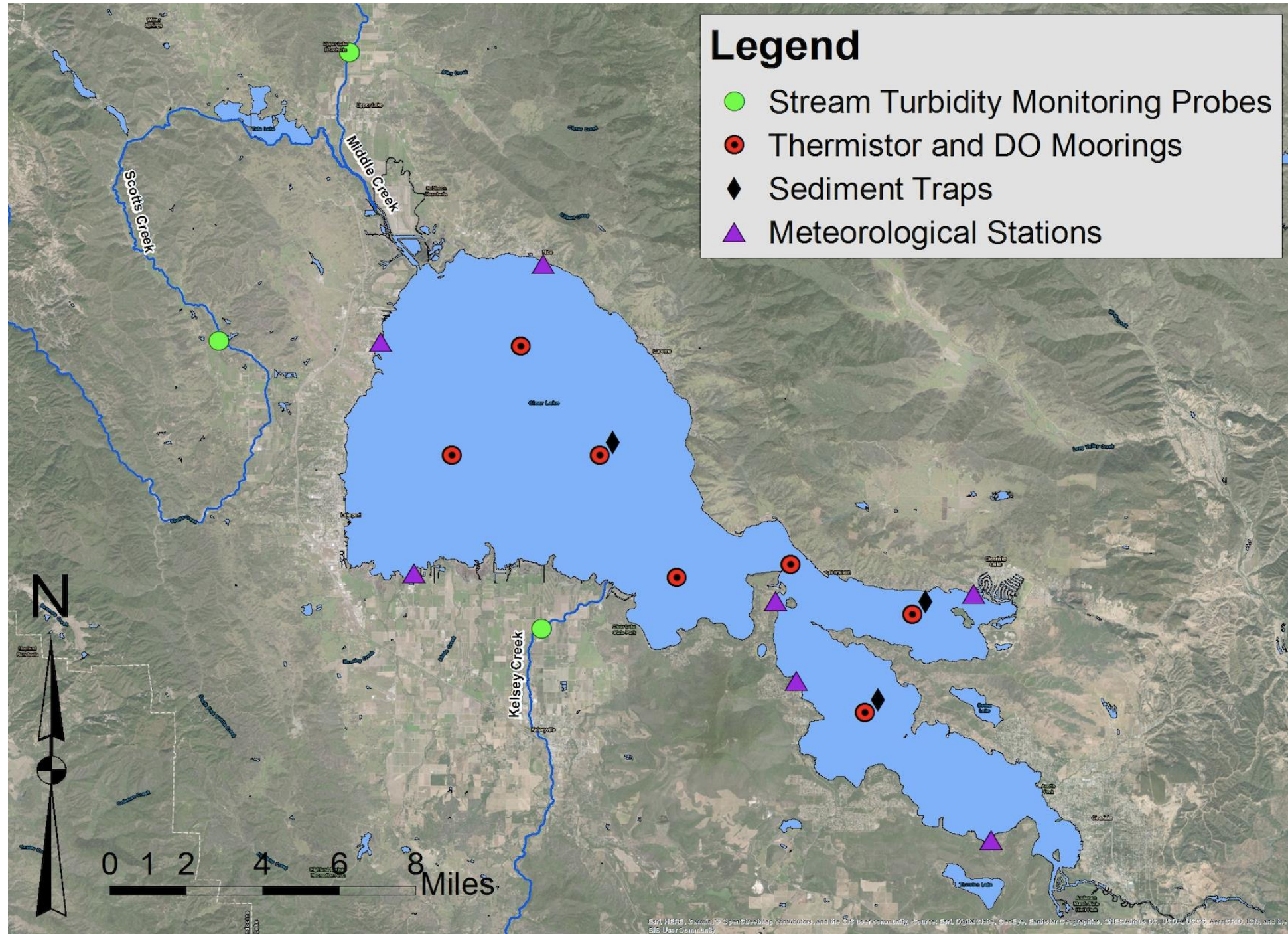
What are the **factors** affecting the different pathways?



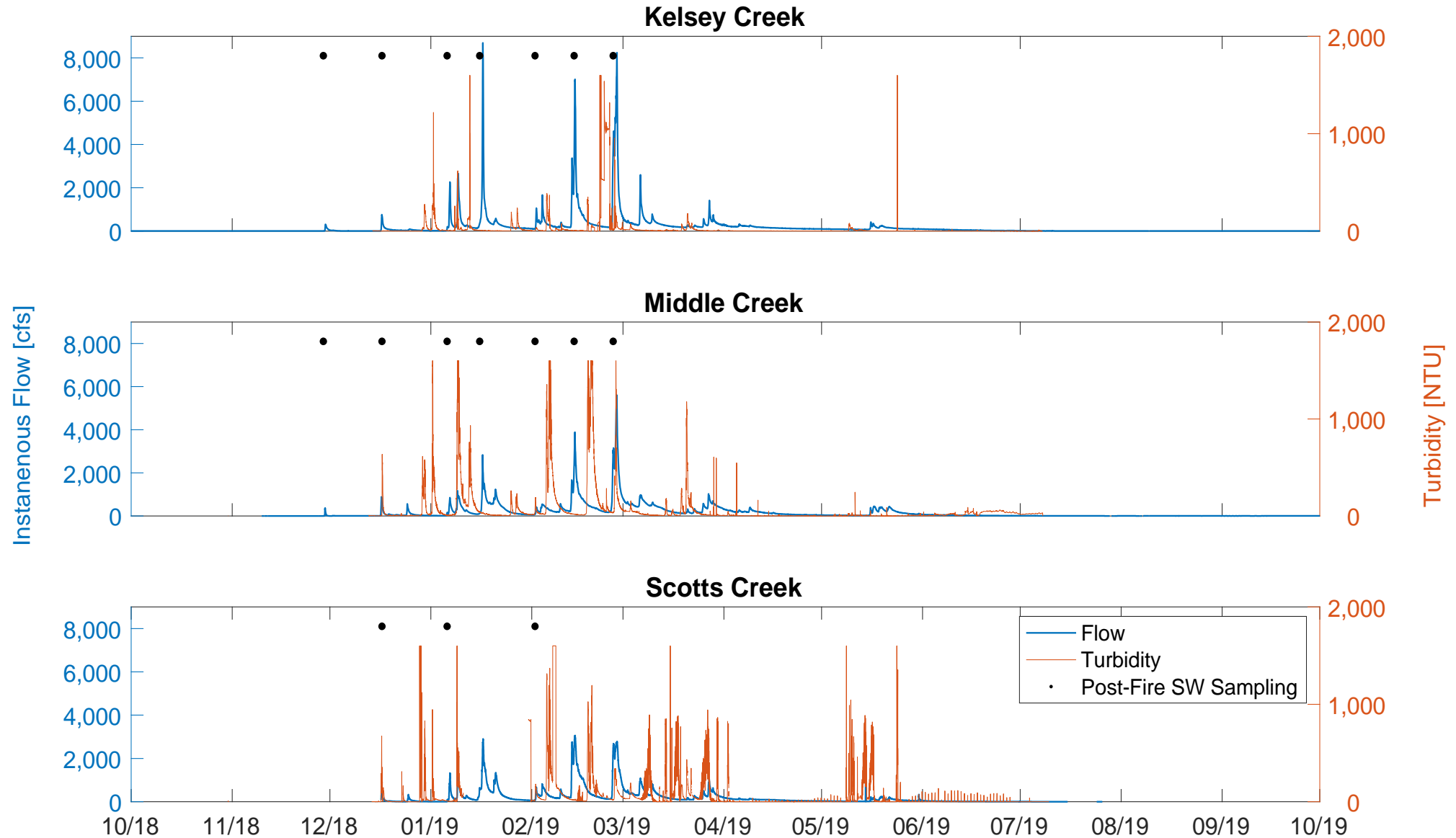
Knowing these, how can we change the system to produce the desired outcomes in the face of future changes (e.g. climate change)?



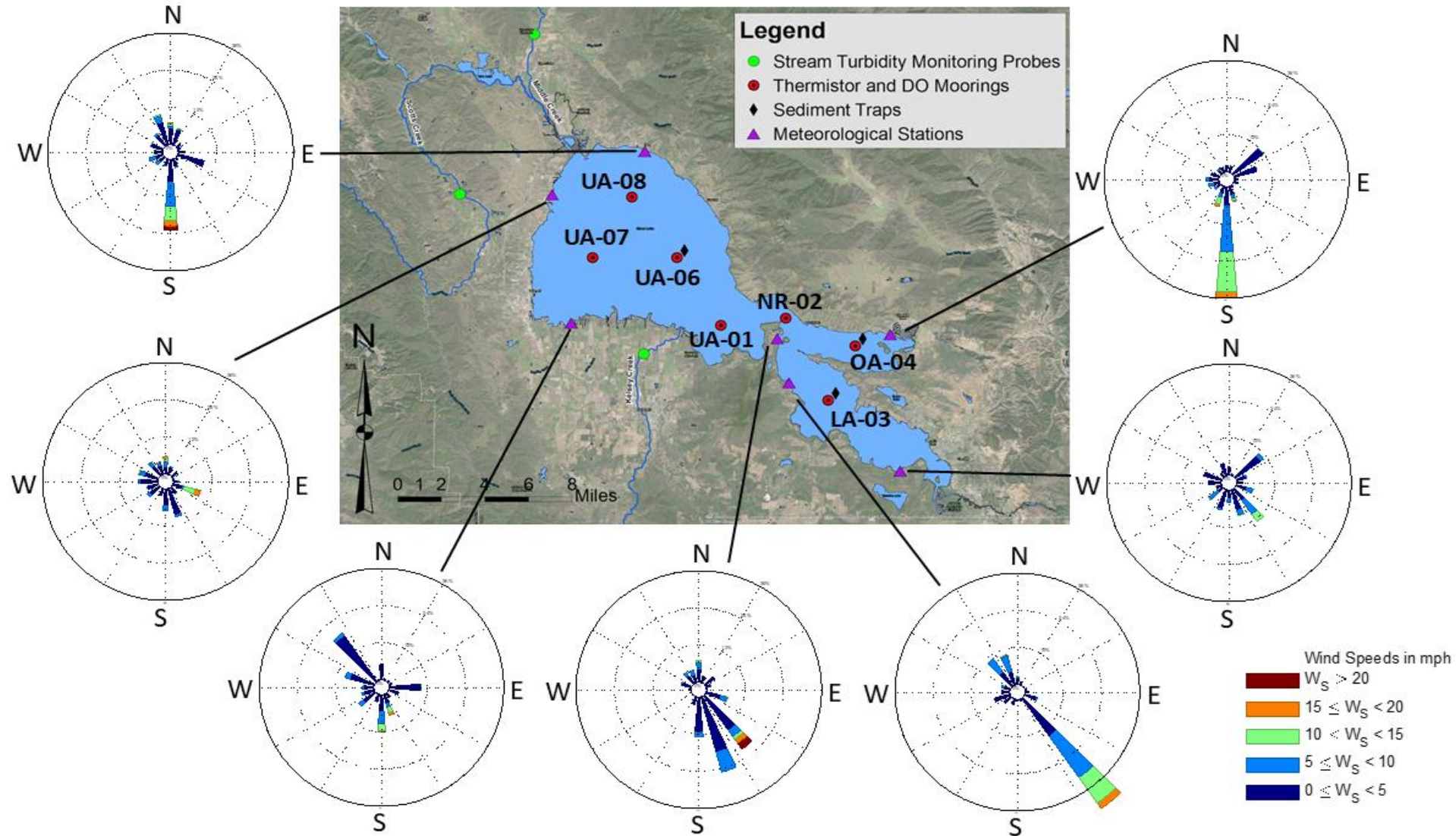
Field Sampling



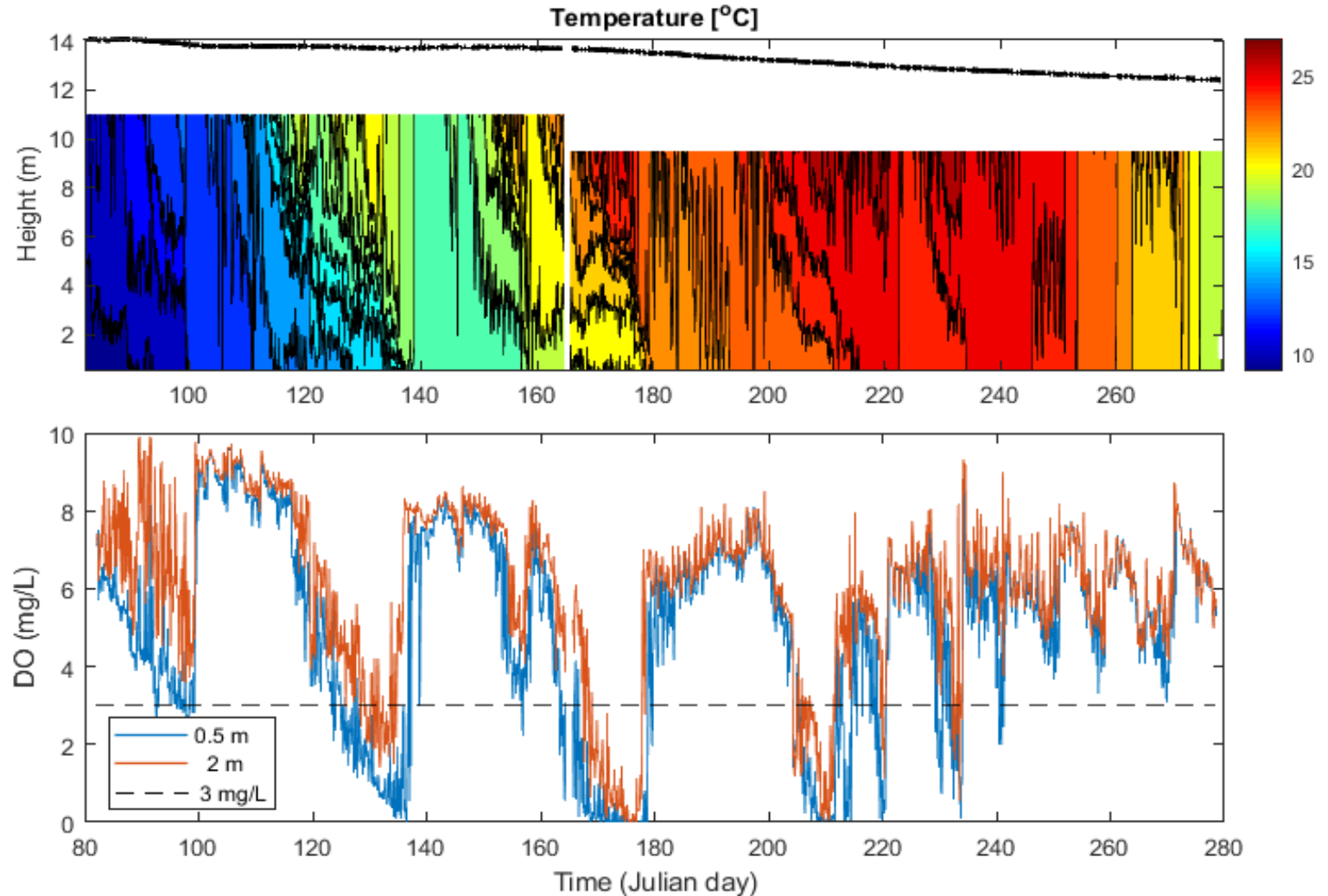
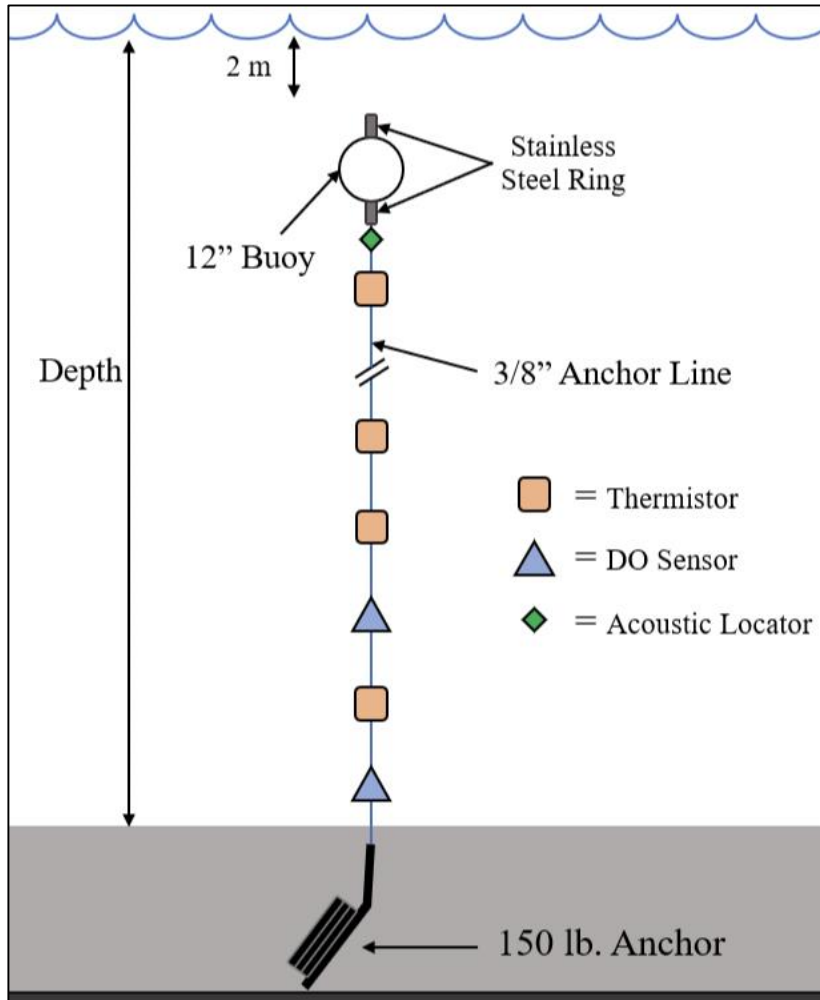
Stream Contribution to Particles and Nutrients?



Meteorology Drives Motions in the Lake?

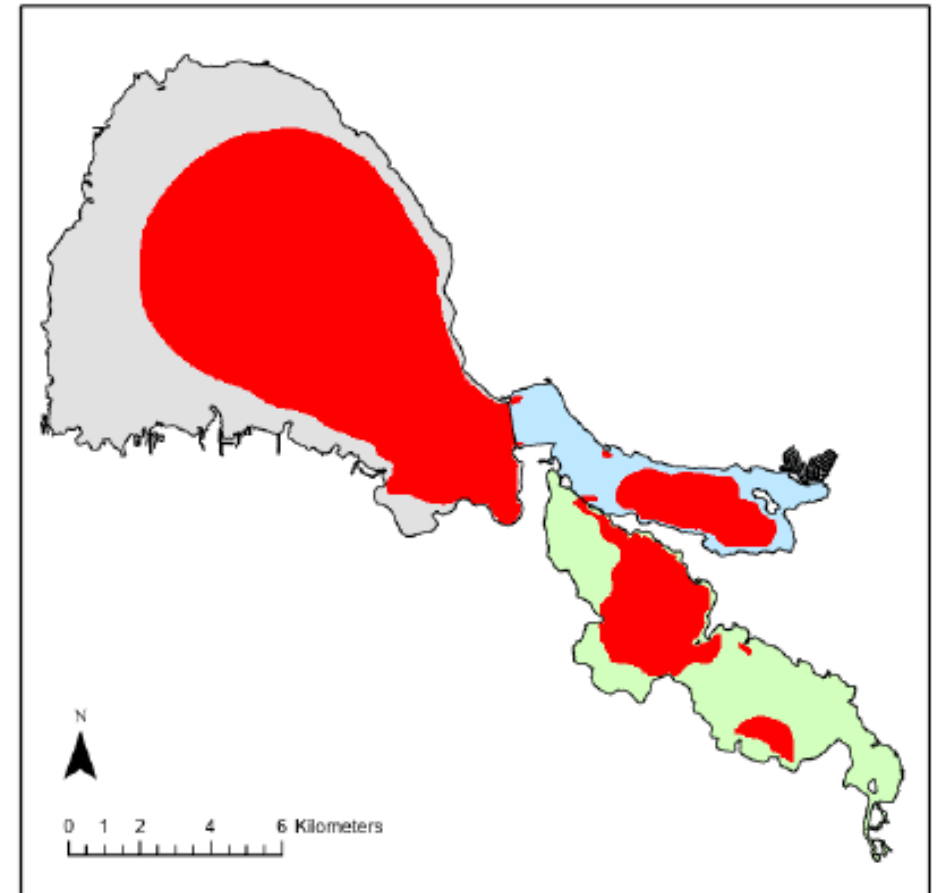
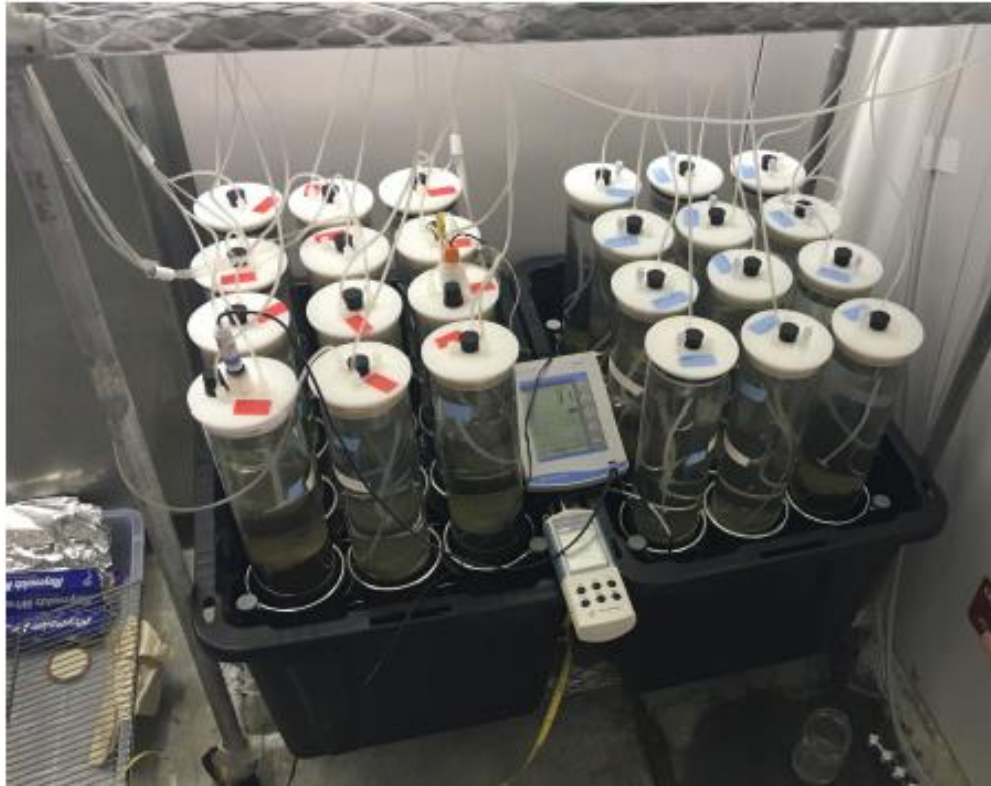


Lake Temperature and Dissolved Oxygen Change Over Time?



Spring and summer temperatures and dissolved oxygen at LA-03

Is There a Phosphorus Flux From the Sediments?



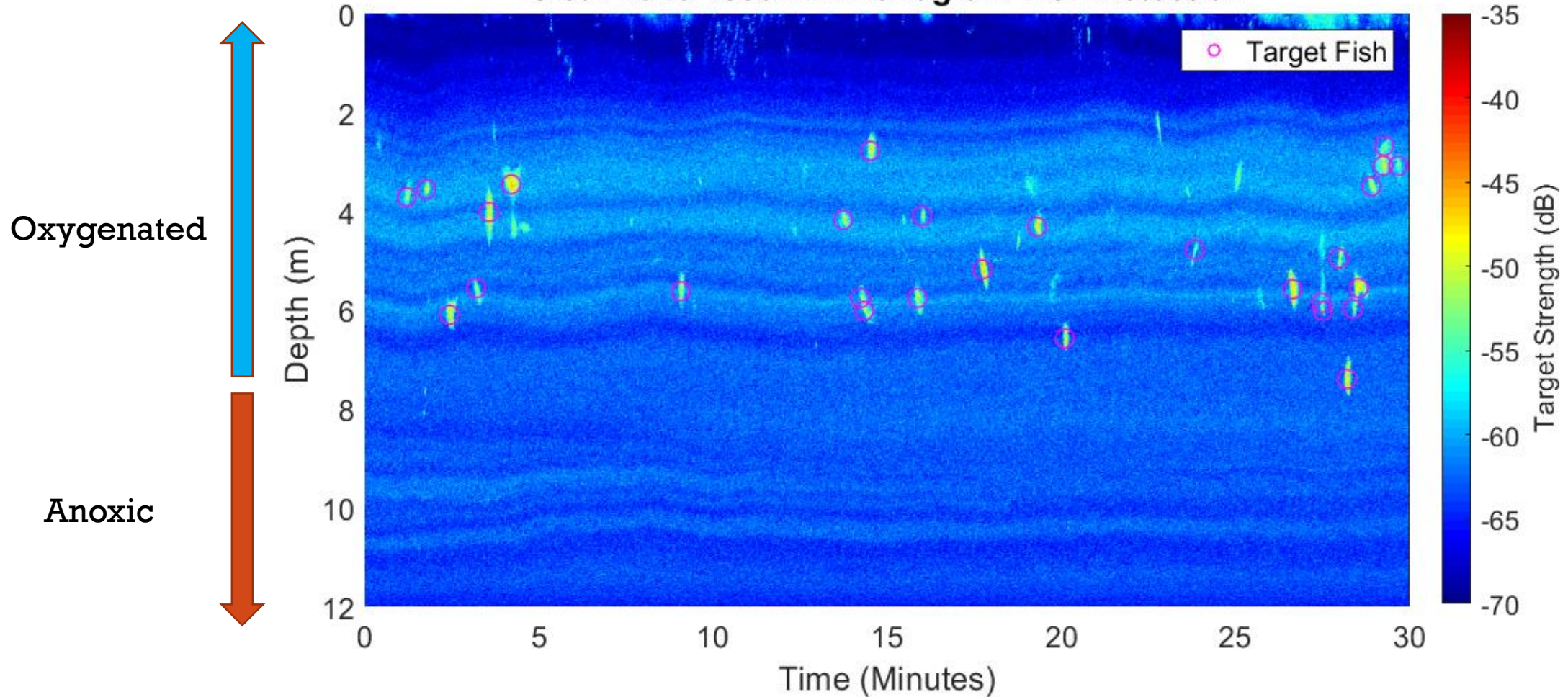
P-Loading Source	P-Species	Annual Load (MT yr ⁻¹)	% Annual SRP load
External	SRP	37.1 - 51.4 ¹	59-67%
Internal	SRP	25.6	33-41%

*Red represents **anoxia** during the stratified period in 2019*



Oxygen Distribution and Fish Populations?

Clear Lake 1000 kHz Echogram Fish Detection



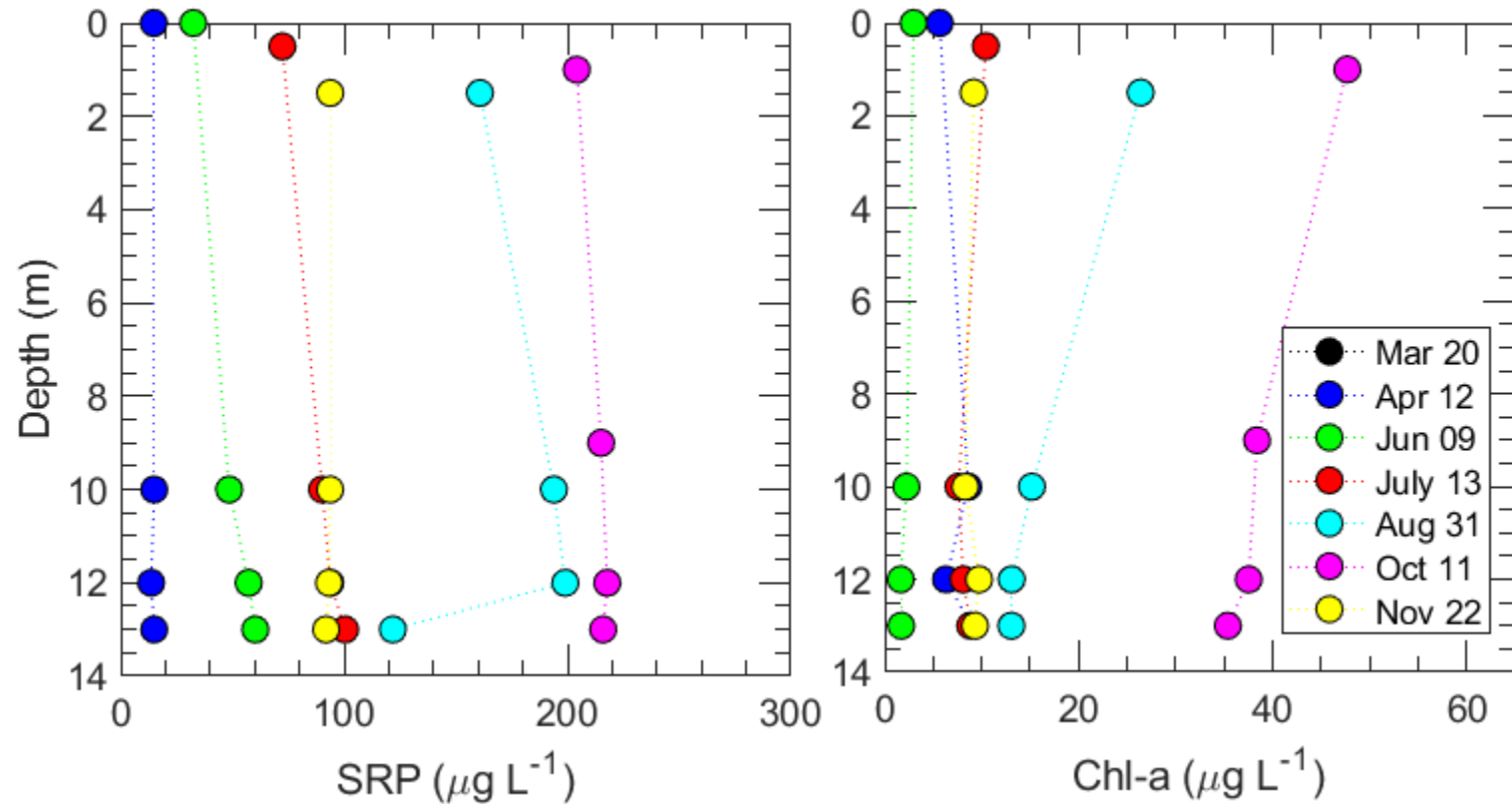
Echogram in the Lower Arm. The magenta circles indicate fish, and white line marks the 3 mg L⁻¹ oxycline



Water Quality Changes Over Time?

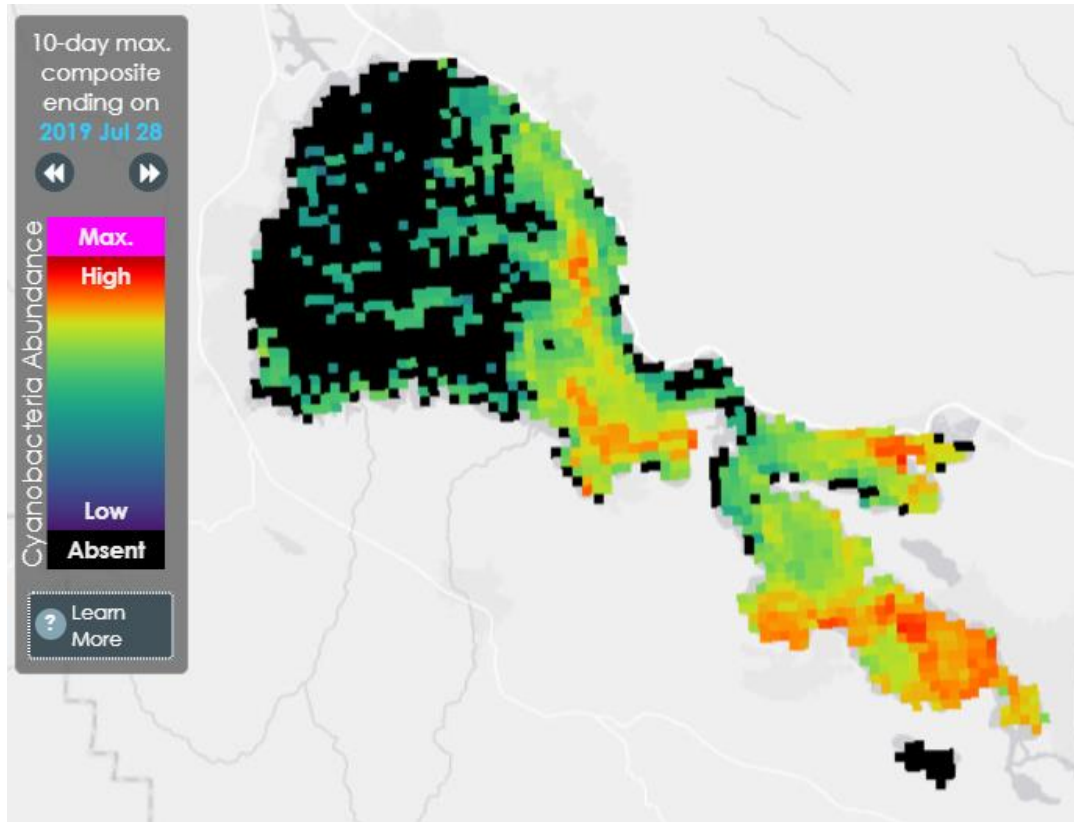
List of Constituents

- **Nitrogen forms:** dissolved nitrite + nitrate ($\text{NO}_2 + \text{NO}_3$), total dissolved nitrogen (TDN), particulate nitrogen (PN)
- **Phosphorus forms:** dissolved orthophosphate phosphorus (SRP), total dissolved phosphorus (TDP), particulate phosphorus (PP)
- Particulate **carbon** (PC), dissolved organic carbon (DOC)
- **Chlorophyll-a**, phytoplankton identification, and enumeration
- **Particle size distribution**



Direct relationship between **SRP** and **Chl-a** →
Oxygenation may reduce the *internal SRP load* and
control *algae blooms*

Monitoring Cyanobacteria (HABs)



**Improving and Validating SFEI/NOAA
Harmful Algal Blooms Remote Sensing Tool**
(fhab.sfei.org)

Discrete
Sampling



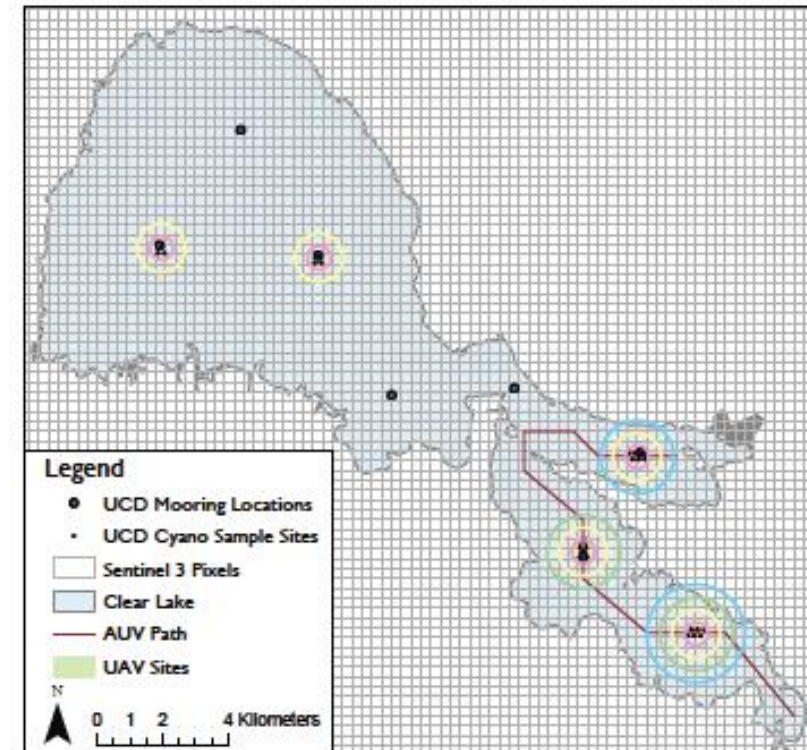
Radiometer



UAV



AUV



Key Accomplishments to Date

- **High-Resolution** data for **Streams, Meteorology and Lake**
- **Lake Chemistry** at 7 stations, 7 times in 2019
- Conducted **Lake Current Experiments**
- Conducted **Sedimentation Measurements**
- Conducted **Lab Nutrient Release Experiments**
- First Measurements of “**Internal**” **P-Release Due (~40% of Total)**
- Conducted **Cyanobacterial Distribution Measurements**
- Have Developed a **Three-Dimensional Model for the Lake**
- Commenced **Collaborative Research with USGS**
- Launched a **Public Data Portal**: <https://terc-clearlake.wixsite.com/cldashboard>



Future Directions

- Responsive to **Requests** from the Blue Ribbon Committee
- Continue **High-Resolution Measurements and Water Chemistry**
 - Needed for *model calibration and validation*
- Model Exploration of **DO Enhancement Techniques**
- Model Exploration of **Fate of Stream and Culvert Loads**
- Model **Controls on Cyanobacteria**
- Model **Climate Change Impacts**
- Continue **Cyanobacterial studies** (funding dependent – NIWR, CSIRO)
- Continue **Watershed Modeling** (funding dependent – BRC recom.)
- Measurement of **Lake Bathymetry** (funding dependent – BRC recom.)
- Link 3-D Model to **Mercury Model** with USGS (funding dependent)



Research Team

Questions?

<https://terc-clearlake.wixsite.com/cldashboard>

Name	Position
Geoff Schladow	Principal Investigator (PI)
Alex Forrest	Co-PI
Steve Sadro	Co-PI
Alicia Cortes	Project Scientist
Lidia Tanaka	Project Scientist (Phycologist)
Shohei Watanabe	Data manager & Project Scientist
Goloka Sahoo	Project Scientist (Hydrology)
Tina Hammell	Research Associate (Chemistry)
Anne Liston	Research Associate (Chemistry)
Steven Sesma	Research Associate (Chemistry)
Katie Senft	Research Associate (scuba & field)
Brandon Berry	Research Associate (scuba & field)
Drew Stang	Graduate Student
Micah Swann	Graduate Student
Nicholas Framsted	Graduate Student
Ruth Thirkill	Graduate Student
Samantha Sharp	Graduate Student
Carmen Woods	Project administration
Lindsay Vaughan	Technical Staff
Niella McWeeney	Undergraduate Student
Jhonatan Romero	Undergraduate Student
Taylor Lander	Undergraduate Student
Eda Ceviker	Undergraduate Student
Siobhan Sher	Undergraduate Student